Managing Pinyon-Juniper Ranges for Wildlife

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USDA Forest Service
General Technical Report RM-47
November 1977

Rocky Mountain Forest and
Range Experiment Station
Forest Service
U. S. Department of Agriculture
Fort Collins, Colorado 80521

Abstract

Reviews, in a general way, the distribution and composition of pinyon-juniper woodlands in the western United States and the animal communities occupying the woodlands. Describes general procedures for managing the woodlands in a manner advantageous to wildlife.

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Introduction

The pinyon-juniper woodland type occurs throughout much of the southern and central interior portions of western North America. These discontinuous woodlands are scattered throughout a large area that varies in topography, precipitation, and climatic severity. The pinyon-juniper woodland type is potentially useful to the game manager, frustrating to the stockman, of some potential economic usefulness to citizens of the Southwest, and a visual relief to the western visitor anxious for a view of a tree.

Extent and Composition of Pinyon-Juniper Woodlands

Trees of the genus *Juniperus* grow throughout North America, although the pinyon-juniper association generally occurs from central Mexico through west Texas, into the Four Corner States of New Mexico, Colorado, Arizona, and Utah, and west through Nevada into eastern and central California. The different pinyons and junipers important to this woodland type are described in detail by Tueller and Clark (1975).

The pinyon (*Pinus edulis* Engelm.) is a relatively small, bushy, needle-leaved evergreen tree, 15-35 feet tall, which occurs either in pure stands or in association with junipers on dry, rocky foothills, mesas, plateaus, and lower mountain slopes between the desert shrub, desert grassland or chaparral type, and coniferous forests. The pinyon occurs frequently in the Four Corner States (fig. 1) in a zone between 5,000 and 7,000 feet. Pinyons are widespread, abundant, and highly drought resistant, growing in a zone that frequently receives only 12-18 inches of rain a year (Little 1950). Summers are very dry in the northern and western portion of the range but become increasingly moist along a southeasterly gradient.

Single leaf pinyon (*Pinus monophylla* Torr. and Frem.) is common throughout the lower elevations (2,000 to 7,000 feet) of the isolated mountain ranges of the Great Basin (fig. 1), where it occurs as pure stands or in association with junipers on arid, gravelly slopes and mesas. This tree occurs to the north and west of the pinyon, and its range extends to eastern and central California and northern Baja California (Critchfield and Little 1966).

The Mexican pinyon (*Pinus cembroides* Zucc.) is widespread at low elevations in the mountains bordering the arid plateau of northern Mexico, and ranges from west Texas to central Mexico (Critchfield and Little 1966). The approximate distribution of the Mexican pinyon within the United States is indicated by the shaded pattern in figure 1.

At least four major species of junipers are associated with these three pinyons in the western United States. Junipers are small to medium-sized, scale-leaved evergreen trees up to about 40 feet tall. In addition to occurring in pinyon-juniper woodlands, scattered alligator junipers (*Juniperus*

Figure 1. Approximate ranges of three species of pinyon pines in the United States. Pice=*Pinus cembroides;* Pied =*P. edulis;* and Pimo=*P. monophylla*.

Pinyon-juniper stands vary in appearance from dense with little herbaceous understory (left) to open with good grass cover (right).

deppeana Steud.) grow on hillsides and mountains in the chaparral and oak woodland types and within lower portions of ponderosa pine forests at about 4,500 to 8,000 feet. Their approximate range in the mountainous terrain of the southwestern United States is indicated by the shaded pattern in figure 2.

Figure 2. Approximate ranges of four important species of juniper that occur with pinyon pines in the United States. Jude=*Juniperus deppeana;* Jusc=*J. scopulorum;* Jumo=*J. monosperma;* and Juos=*J. osteosperma.*

Rocky Mountain junipers (*J. scopulorum* Sarg.) occur as scattered trees in pinyon-juniper woodlands and along the lower edges of ponderosa pine forests at about 5,000- to 9,000-foot elevations. They grow in mountains and canyons in a widely scattered distributional pattern throughout the Rocky Mountain region (fig. 2).

One-seed junipers (*J. monosperma* (Engelm.) Sarg.) are common throughout suitable range in New Mexico, and are found in east central and southeastern Arizona, south central Colorado, and west Texas (fig. 2). The tree is common and widespread on plains, plateaus, and foothills of pinyon-juniper woodlands, and occurs in pure open stands in the upper portion of desert and desert grassland habitats at 3,000- to 7,000-foot elevations.

Utah juniper (*J. osteosperma* (Torr.) Little) is the most common juniper in Arizona where it may occur as an associate within the chaparral or as an invader in short grass prairies and desert grasslands. This tree is abundant on semiarid plains, hills, and mountains, and may occur either in pure stands or in conjunction with pinyon. The tree is found at 3,000- to 7,500- foot elevations throughout much of the Great Basin (fig. 2). Other juniper species, not listed on figure 2, such as western juniper (*J. occidentalis* Hook.) and California juniper (*J. californica* Carr.), may also be locally important in pinyon-juniper woodlands (Lanner 1975).

Precipitation during the growing season may affect the distribution of different trees in the woodland type (Woodin and Lindsey 1954). *Pinus cembroides* may be more adapted to dry conditions than are *J. monosperma, P. edulis,* or *J. scopulorum.* East of the Continental Divide, the different associations of pinyon-juniper trees are correlated with the start of summer rains. *Pinus edulis* grows in association with *J. monosperma* in areas of New Mexico receiving the first heavy rains in July and August, and with *J. scopulorum* in south central Colorado where significant rains occur in April (Woodin and Lindsey 1954).

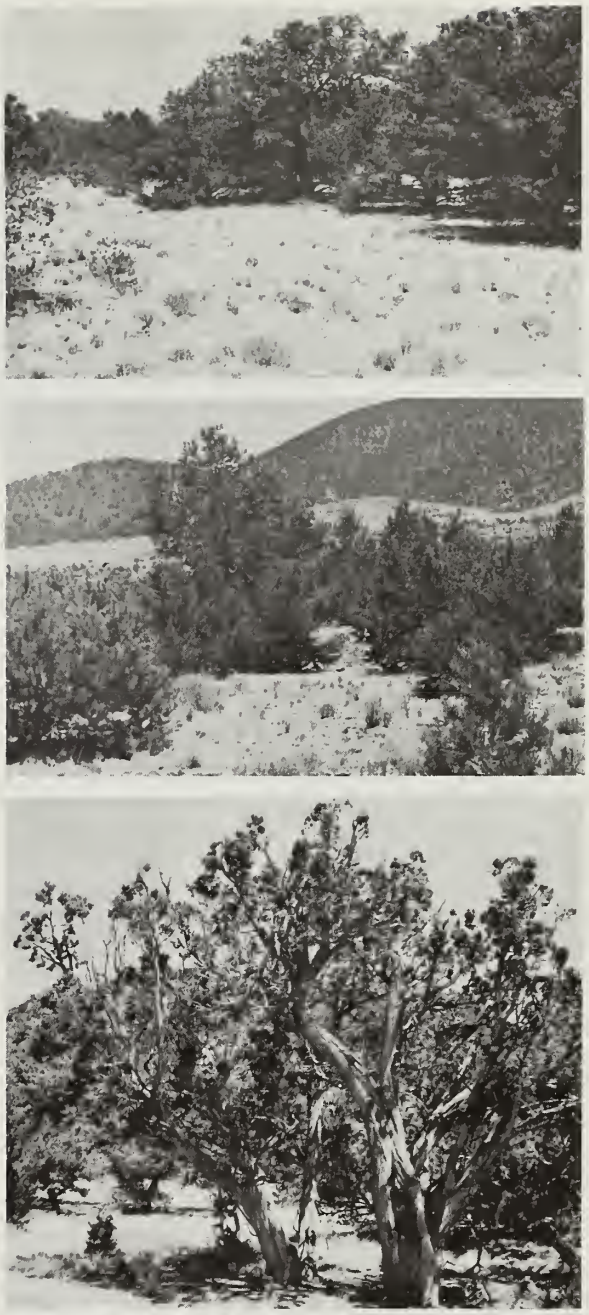
The pinyon-juniper woodland, a climax vegetation, occurs on perhaps 60 million acres, on a variety of different soils derived from limestone, lavas, and sandstones as parent materials. Soils supporting pinyons and junipers are frequently coarse textured, low in organic matter, and alkaline (Barrett 1962). Soil moisture in pinyon-juniper habitats may be deficient during both the spring and autumn droughts characteristic of the Southwest.

Junipers begin growth in the spring, if soil moisture from the winter is adequate, but growth may cease during the spring drought period only to resume again after the summer rains begin. Growth slows again towards the end of the growing season. The capability of junipers to cease and resume growth with changing moisture conditions may account for their ability to survive on dry, exposed sites (Herman 1956).

Variations in resistance to drought and tolerance to frost among pinyons and junipers affect the tree composition of this woodland type. Junipers are generally more drought-resistant than are pinyons, so, they occur at lower altitudes and survive droughts better. Pinyon-junipers are characterized by slow rates of growth, and mature trees in pinyon-juniper woodland may be 200 or 300 years old. There are obvious differences in annual rainfall, summer rainfall, length of growth season, and severity of winter and summer climates in the broad pinyon-juniper woodland zone. Overall, the climate of the pinyon-juniper type is rather severe for tree growth, characterized by relatively low precipitation, hot summers, high wind, low relative humidity, very high evapotranspiration rates, and much clear weather with intense sunlight (Clary et al. 1974).

Pinyon-juniper woodlands vary from very dense to relatively open stands with only occasional trees. Tree density and other ecological considerations affect the abundance of midstory shrubs and understory herbage. Pinyons and junipers may inhibit the production of herbage close to the tree (Tueller and Clark 1975), and tree canopies may shield light from understory vegetation. The herbaceous understory may be the only other vegetation present where the pinyon-juniper woodland has invaded a grassland habitat. The woodland may also contain a shrub midstory where pinyon-junipers have invaded habitats where shrubs have been or are an important vegetation form.

Pinyon-juniper woodlands possess a comparatively simple compositon. All the major understory species within the woodland are also found in the adjacent forest, grasslands, or shrub steppes (West et al. 1975). Sagebrush (*Artemisia* spp.), bitterbrush (*Purshia* spp.), and rabbitbrush (*Chrysothamnus* spp.), and a variety of cold season herbages occur in northern and western pinyon-juniper woodlands. Apache-plume (*Fallugia paradoxa*), a variety of oaks (*Quercus* spp.), manzanita (*Arctostaphylos* spp.), and a variety of warm season herbages occur with the pinyon-junipers in the southern and eastern woodlands (West et al. 1975).



Pinyon-juniper stands range from relatively dense, pure stands of pinyon (top) to intermixtures of the species (center). At lower elevations, Utah juniper forms extensive open stands (bottom).

Animals Inhabiting Pinyon-Juniper Woodlands

Birds

Pinyon-juniper woodlands vary in their successional state, floristic composition and microclimate. As a regional vegetation type, the woodlands provide a varied habitat for wildlife. Junipers are preferred for nesting by birds, possibly because of their shape, the numbers of cavities within their trunk, and the stringy and fibrous bark which provides a quality nesting material. Birds like the pinyon jay (*Gymnorhinus cyanocephalus*), plain titmouse (*Parus inornatus*) and common bushtit (*Psaltriparus minimus*) are obligate to these woodlands (Hardy 1945). He also lists 14 other species that nested within pinyon-juniper woodlands in east central Utah. Scott and Patton (1975) list 26 bird species that are cavity nesters in pinyon-juniper woodlands, and Frischknecht (1975) notes six species of raptors also nesting in this type. Hardy (1945) identified at least 79 bird species that were present in his Utah study area either as summer, winter or permanent residents. A total of 144 different species of birds has been observed in pinyon-juniper habitat at Fort Bayard in southwestern New Mexico. Future studies may show that many bird species which are summer residents throughout the pinyon-juniper type nest within these woodlands.

Besides providing nesting cover, pinyon-juniper trees provide seeds and berries that are eaten by many bird species as well as other vertebrates and invertebrates which, in turn, may be important in avian foodchains.

Reptiles and Insects

The reptile and invertebrate populations are not as abundant in the pinyon-juniper as they are in warmer and more humid forest environments. Frischknecht (1975) summarizes literature indicating that insectivorous and cannibalistic lizards, horned toads and a variety of snakes, including rattlesnakes, have been reported from pinyon-juniper woodlands. Spiders and insects from the Chermidae, Formicidae, Ichneumonidae, Diptera, Cicadellidae, Hemiptera, Coleoptera, and Othoptera groups were collected from the pinyon-juniper woodlands on the Kaibab plateau. A variety of midges, moths, and beetles may damage reproductive tissues of junipers. The nature of the vegetation growing in association with pinyon and juniper trees further modifies the invertebrate fauna present (Frischknecht 1975).

Small Mammals

Pinyon-juniper woodlands occupy a belt between the desert grassland, desert shrub, chaparral,and the coniferous forests. A variety of small mammals extends into the pinyon-junipers from both warm and dry lower, and cool and wet higher habitats. Some species such as pinyon mice (*Peromyscus truei*) and some wood rats (*Neotoma* spp.) seem more-or-less restricted to the pinyon-juniper type. Small carnivores like gray foxes (*Urocyon cinereoargenteus*), bobcats (*Lynx rufus*), coyotes (*Canis latrans*), weasels (*Mustela* spp.), skunks (*Mephitis* spp.), badgers (*Taxidea taxus*) and ringtails (*Bassariscus astutus*) search for prey in pinyon-juniper woodlands.

The inner bark of pinyon twigs has been reported by Reynolds (1966) to be eaten by Abert squirrels. Ringtails, racoons (*Procyon lotor*), coyotes, gray foxes, rabbits, and numerous rodents have been reported to eat berries and seeds from junipers and pinyons (Martin, Zim, and Nelson 1961).

Large Mammals

Pinyon-juniper woodlands have great value as habitat for large mammals. Mule deer (*Odocoileus hemionus*), white-tailed deer (*Odocoileus virginianus*), and elk (*Cervus canadensis*) may occur throughout the year in certain pinyon-juniper ranges in Arizona and New Mexico. Other mule deer and elk herds throughout the West depend on this habitat as deep snows in and above the yellow pine belt force large concentrations of animals from high summer ranges into the pinyon-juniper zone. Pronghorn antelope (*Antilocapra americana*) may use some pinyon-juniper ranges for important cover as usual grassland habitats become more accessible to man. Frischknecht (1975) indicated that desert bighorn sheep (*Ovis canadensis* nelsoni) utilize those pinyon-juniper ranges in rough areas which are otherwise suitable for bighorn habitat. Buffalo (*Bison bison*) roam pinyon-juniper range in southern Utah, and wild horses extensively use pinyon-juniper woodland in various parts of the West. Undoubtedly, the greatest use of forage within the type is by domestic stock which, when not carefully regulated, may utilize and trample foodstuffs required by wild herbivores. Large carnivores like mountain lions (*Felis concolor*) and bears (*Euarctos americanus*) also feed within this habitat.

Leaves and fruit of pinyon and juniper trees are eaten by pronghorn antelope, mule and white-tailed deer, elk and mountain sheep (Martin et al. 1961) as well as domestic stock. Juniper foliage ranged from 1% to 38% of the contents of deer stomachs collected throughout the West

Merriam's turkey is a frequent inhabitor of pinyon-juniper stands.

Pinyon-juniper trees and whiteface cattle in a savannah setting present a pleasing scene in the west.

(Anderson et al. 1965, Boeker et al. 1972, McCulloch 1969). Palatability of juniper foliage varies according to the species of the tree, among individual trees, and with the availability of other foods (Frischknecht 1975, Jobman 1972). Juniper foliage also comprised 34% of the contents of elk stomachs collected during winter from New Mexico (Short et al. 1977).

The quantity and compostion of the vegetation growing in association with pinyon-juniper influence the importance of pinyon-juniper woodland as big game habitat. The usefulness of midstory and understory plants as food for game animals has been indicated in several food habit studies (Kufeld et al. 1973). Neff (1974), working in natural pinyon-juniper woodlands on the Beaver Creek watersheds in central Arizona, lists browse from such dwarf trees and shrubs as mountainmahogany (*Cercocarpus breviflorus*), desert ceanothus (*Ceanothus greggii*), shrub live oak (*Quercus turbinella*), wavyleaf oak (*Q. undulata*), Gambel oak (*Q. gambelii*), cliffrose (*Cowania mexicana*), and plant parts of wright eriogonum (*Eriogonum wrightii*) and sulfur eriogonum (*E. cognatum*) as seasonally important foods for deer. A large variety of other midstory and understory plants is also consumed, but account for lesser portions of the overall diet of deer. Sagebrush is a major food of deer in pinyon-juniper woodlands in several states (Kufeld et al. 1973). Sagebrush exceeded 70% of the mean contents of the stomach of deer on overcrowded ranges and 50% of the contents of the stomach of deer after deer and cattle populations were reduced on Kaibab winter range. At Fort Bayard, leaves of mountainmahogany and oaks are important in the diet of mule deer at all seasons, and various forbs are important in spring and summer (Boeker et al. 1972). Elk also browse shrubs at all seasons and consume forbs during summer, and grasses during summer and autumn (Short et al. 1977).

The pinyon-juniper woodland is generally a climax vegetation type throughout its range. The trend is toward increased tree density and, finally, a dense canopy cover. Inverse relationships exist between tree basal area and the amount of woodland ground cover (Woodin and Lindsey 1954). Except for foods produced by pinyons and junipers, total food production and the variety of plant foods produced decline with the increasing maturity of pinyon-juniper woodlands.

Total small mammal and bird populations may diminish as the woodland canopy becomes more dense. Habitat diversity is lessened, and those species using midstory and understory plants for habitat and food should be expected to diminish as the midstory and understory plants become less important. A few species like pinyon mice and pinyon jays may, however, be favored as the woodland becomes more dense. Deer and elk use, as measured by pellet group indices, declined as tree canopies became more dense at Fort Bayard in southwestern New Mexico (Short et al. 1977). Perhaps this occurred because the production of more desirable foods is drastically reduced in dense pinyon-juniper stands. Usefulness of the habitat to domestic stock is also reduced as the herbaceous understory declines.

Open stands of pinyon-juniper with abundant midstory and understory vegetation seem most favorable to many wildlife species. Manipulation of dense pinyon-juniper woodlands to provide this habitat diversity is desirable habitat management for many species. Unfortunately, the greatest livestock productivity of some pinyon-juniper ranges is realized with the clear-cutting of the woodland and the establishment of a grass cover. This treatment may be unfavorable for many wildlife species and may represent a major destruction of wildlife habitat. For public lands, at least, it is desirable to weigh the requirements of both wildlife and the domestic livestock industry when managing pinyon-juniper woodlands.

Bulldozing can be used either to destroy or to manage, pinyon-juniper woodland.

Wildlife Habitat Management In Pinyon-Juniper Woodlands

Economic Considerations

Much of the early pinyon-juniper management was simply an attempt to clear as much woodland as cheaply as possible. Dragging a heavy cable or anchor chain between two large tractors to uproot trees and brush was, and still is, the most common mechanical control. Bulldozers, tree crushers and chainsaws have also been used. Large blocks of woodland were cleared with little regard for any impact on wildlife or for aesthetic considerations. Downed trees were usually windrowed or piled and burned. From 1945 to 1965, control was mostly an attempt to improve range for domestic livestock.

Modification of dense stands of pinyon-juniper has always been expensive. Large woodland control operations are expensive because of the low demand and market value for timber products such as fuelwood, fenceposts, lumber, veneer, resins, and pulpwood (Arnold et al. 1964). Benefits from pinyon-juniper clearing have largely come from the value of additional livestock forages produced when the tree canopy is removed. Forage production, however, varies greatly between clearing sites due to differences in soil fertility and soil water retention capabilities. Only when posttreatment forage production is high, do benefits equal or exceed the costs of clearing pinyon-juniper woodlands using mechanical techniques (Clary et al. 1974). Although pinyon-juniper woodlands comprise vast acreages, there is little opportunity to appreciably increase water runoff from these semiarid lands because of their high evapotranspiration rates and, therefore, little justification for large-scale pinyon-juniper conversions as watershed improvement practices (Clary 1975).

Some management of pinyon-juniper woodlands is justified to increase the yield of products which can be cropped from this type. Some areas near metropolitan centers can be managed both for the production of Christmas trees and pinyon nuts. Junipers can also be selectively harvested for firewood, fenceposts and various wood products such as charcoal. In the future, pulp and a variety of other wood products may be obtained from this forest type. Clearly greater economic use could be made of the woodland products. Almost any use that selectively harvests individual trees or small groups of trees seems compatible with the management of important wildlife species.

Livestock vs. Wildlife

Management of pinyon-juniper woodlands for wildlife and for range stock varies in the degree of overstory removal. There is greater multiple use value in the partial removal of the overstory or in clearing only small blocks of pinyon-juniper woodland to produce some additional forage. Large clearings which might produce abundant herbage for livestock might also destroy extensive blocks of wildlife habitat.

Pinyon-juniper woodlands are quite important for livestock grazing because of their size and because their climate is frequently favorable to range animals. The woodlands provide critical spring and autumn range for many cattle and sheep. Complete clearing of pinyon-juniper woodlands to increase herbage production for livestock may be economically justified on highly productive grassland sites where little wildlife use occurs and herbage productivity has been drastically reduced by invading trees. Any public land considered for a conversion treatment should be

intensively surveyed to determine its potential for herbage production and its present value as wildlife habitat. Results from mammalian surveys, bird censuses, and the presence or absence of desirable midstory shrubs are indicators of wildlife habitat values. It is difficult to justify the conversion of woodland which serves as important winter range for deer and elk, or which provides important habitat for some uncommon, rare or endangered species. It is equally difficult to justify large conversion treatments on areas with the potential for producing only low to marginal amounts of additional herbaceous forage after treatment.

Cattle, sheep and horses primarily consume grass. They also eat forbs, browse leaves, seeds, and fruits—items important to both game and nongame wildlife. Heavy consumption of these latter forages by livestock from spring to early autumn may eliminate foods required by wildlife during late autumn and winter. Livestock grazing pressures have to be managed in some areas so that seasonal grazing does not permanently damage vegetation and soil or destroy wildlife forage.

Overgrazing and trampling by cattle and sheep may have contributed to the recent invasion of junipers into areas that were formerly juniper savannahs or grassland inclusions within the pinyon-juniper woodlands (Johnsen 1962). Other grasslands, at lower elevations, may have drier and warmer summers and may not be as susceptible to invasion. Short droughts are detrimental to the establishment of junipers in grasslands because dormant grasses are not as severely affected as juvenile trees. Large trees with established root systems withstand drought conditions better than grasses, however (Johnsen 1962). Established junipers thus become dominant during droughts. Large junipers also are not killed as readily by grass fires. Reduction in herbaceous competition and lack of grass fires, since fire suppression has become so efficient, have probably accelerated the invasion of junipers into suitable grasslands (Johnsen 1962).

Role of Fire

Pinyon-juniper trees are frequently hit by lightning during summer storms. Burning trees that endanger manmade structures or commercial forests require prompt fire suppression efforts. Dense pinyon-juniper woodlands usually have limited fuels to carry fires because of the inverse relationship between tree canopy cover and the herbaceous understory. A crown fire, even with high wind and low humidity, will carry only where the canopy cover is very dense. It will suppress itself in areas where the pinyon-juniper density is reduced.

Throughout the pinyon-juniper region, charred snags show that wildfires have helped maintain openings in many pinyon-juniper woodlands. Fire produces a patchwork effect which may be desirable even though burned snags may not be esthetically pleasing.

Prescribed fires in pinyon-juniper woodlands burn slash, kill individually ignited trees, and open some pinyon-juniper woodlands that contain sufficient herbaceous cover to carry fire (Blackburn and Bruner 1975). Alligator junipers and some browse species resprout following fire. Small burns seem more desirable for deer because they create a greater variety of food and cover conditions than do larger burned or unburned areas (McCulloch 1969). Large burned areas may be conditionally acceptable to deer if in remote areas (McCulloch 1969).

Role of Herbicides

Mechanical clearing of woodlands is expensive. As labor and equipment prices soar, there may well be less justification for mechanical range improvement practices in the future. Aerial application of herbicides then becomes potentially important as an alternate method for modifying pinyon-juniper stands. If herbicides could be safely used, their aerial broadcast could create numerous, small, irregularly-shaped openings in terrain that is too rough for mechanical operations. Herbicides may also offer some potential in managing pinyon-juniper woodlands for increased water yields (Clary et al. 1974).

The possibility of destroying midstory shrubs important as food sources, and the esthetically distasteful appearance of dead snags are major disadvantages to herbicide use. Perhaps the greatest disadvantage, however, is the danger that the gross misuse of chemicals might destroy rather than manage a forest type that is important to wildlife in the United States.

Recommendations

The effect of pinyon-juniper manipulation on most wildlife species is not known. Reestablishment of very early successional stages to maximize grass production will favor some wildlife species, while the thinning of mature pinyon-juniper woodlands to provide a mixture of grass,

forbs, shrubs, and trees will favor other species, such as mule deer. The clearing of pinyon-juniper woodlands may, on the other hand, destroy habitat for pinyon jays, pinyon mice, and brush mice. Management of woodlands to favor big game like mule deer may include the following recommendations.

Pinyon-juniper management should be restricted to areas intensively utilized by big game, especially during the winter. Management should provide many small cleared areas interspersed with natural woodland. This arrangement provides greatest "edge" which results in a maximum diversity of vegetation forms. Pinyon-juniper management to favor deer should be confined to extensive and dense stands which are more than one-half mile wide, with average crown cover exceeding 20% and an overall stocking rate greater than 75 trees per acre (McCulloch 1973). Such woodlands, if pinyon-juniper trees are 10 inches or more in diameter, will have a tree basal area of 40 or more square feet per acre. They will also generally have a scarcity of herbaceous and shrubby forages in the mid- and understory. Woodland management thus attempts to restore open stand conditions which may have closed over the last 75 years because of overgrazing, fire suppression, or other conditions.

Woodland openings should be between 100 and 600 feet wide (McCulloch 1973). Wider clearings may be acceptable in very remote areas. Cleared strips should follow natural physical boundaries and assume irregular shapes to be esthetically pleasing. Slash and woody debris should be retained in the numerous small openings. Light to moderate spring and autumn grazing of grasses by cattle is acceptable, but cattle should be fenced from important browse slopes. Sheep should not be allowed to graze areas that are used as winter range by big game (Terrel and Spillett 1975). Uncleared strips of woodland should be at least as wide as cleared strips. Buffer zones of uncleared pinyon-juniper woodland one-fourth-mile wide should be retained along highways, scenic and recreational areas (McCulloch 1973) and archeological sites.

Large junipers in savannah setting are esthetically pleasing, furnish shade, and provide food for wildlife. Removing such trees sacrifices the important cool season forage that grows under the canopy for the possible increased production of an already abundant warm season forage that might have grown in the tree's absence (Clary and Morrison 1973).

Slopes up to 40% in the pinyon-juniper type are used by deer and elk at Fort Bayard (Reynolds 1964). Slopes greater than 15% should not generally be subjected to mechanical clearing or herbicidal treatment because of the possibility of erosion, and the probability that only limited herbage would be produced for livestock.

Large clearings of pinyon-junipers in cold climates will not offer sufficient cover for either deer or cattle during severe winter weather (Neff 1972). Cleared areas should consequently be relatively small and well dispersed within the woodland. Neff (1972) found that clearings up to 330 acres would be used by deer in good weather if shrub oak thickets were retained to provide some cover, acorn crops, and some moderately palatable browse.

Blocks of pinyon-juniper woodlands at Fort Bayard were used less by deer and elk after they had been cleared, and the resulting large clearings tended to disrupt use of the contiguous blocks of pinyon-juniper woodlands that were isolated by the clearings (Short et al. 1977). Scott and Boeker (1977) reported that large conversions of pinyon-juniper woodlands disrupted the use of the habitat by wild turkeys. Many wild species use the edge of clearings where vegetation diversity is greatest. As clearings increase in size, the ratio of edge to total clearing area diminishes and land area is effectively removed as habitat from the woodland type.

Trees should be mechanically removed by methods that will not deplete palatable shrubs. Bulldozing is preferable to cabling on areas supporting large browse plants (McCulloch 1973). The slash, if left scattered and intact, will provide habitat for rabbits, rodents, birds, and big game, and may protect newly established forage plants from excessive use by game and livestock. The variety and abundance of vegetation and rodents was greater on an area of the Kaibab Plateau of northern Arizona that contained slash from recently uprooted pinyon and juniper trees (Turkowski and Reynolds 1970). Populations of small mammals frequently increase for about 3 years following pinyon-juniper conversion treatments (Terrel and Spillett 1975). Numbers of pinyon mice and brush mice, however, usually decline following woodland clearing. Numbers of carnivores in pinyon-juniper treatment areas should be expected to fluctuate as do small mammal populations.

Modified pinyon-juniper woodlands can be reseeded to improve wildlife habitat. The seasons and procedures for planting grasses, forbs, and shrubs in Utah have been listed by Plummer et al. (1968). Seeding a mixture of grasses, forbs (including sweet clover and alfalfa) and shrubs (in-

cluding sagebrush, rabbitbrush and antelope bitterbrush) in late fall through winter before or between mechanical tree clearing operations yielded best results. Sometimes, broadleaved herbaceous species respond well after mechanical clearing without any reseeding. Livestock grazing on rejuvenated lands must be carefully controlled. A healthy grass, forb and shrub community in combination with controlled browsing pressure is important in preventing pinyon-juniper from regaining dominance on treated lands (Stevens et al. 1975). Pinyon-juniper control will also release browse species growing in the midstory, so that current forage production is appreciably increased (McCulloch 1966). Grass yields only increase slowly, however, on sites where few native grass remnants existed prior to pinyon-juniper modification (Clary 1971). Grasses should be reseeded while the soil is still disturbed or just prior to any cabling or chaining operation.

Management Implications

Future demands for products from pinyon-juniper woodlands will probably cause, as Johnson (1975) suggests, all pinyon-juniper units on public lands to be classified according to their potential for management. Much of the woodland will remain intact and will produce some forage for livestock and some cover and food for wildlife. Some areas that have good potential for herbage production and which are not heavily used by wildlife will be converted to produce foods for livestock. Some additional conversion of woodlands will also occur to stabilize highly erodible soils. Because food production is reduced as the woodland canopy becomes dense, some woodlands comprising wildlife winter range will be opened. Small irregularly-shaped openings or narrow contour strips, especially if seeded with important foodstuffs, will provide food, while surrounding natural woodlands will provide cover.

The continued development of stock tanks throughout the woodland will aid both wildlife and livestock. Livestock grazing on public lands throughout the woodland should be more rigorously managed than at present. Treated woodland, that has been successfully converted to productive grasslands, should obtain relatively more grazing pressure than those vast areas of woodland whose conversion cannot be justified. Very little livestock grazing should occur on those public lands that are important wildlife winter range. Important browse slopes within the woodlands should be restricted to use by wildlife. The harvest of pinyon-junipers for woodland products, if done on a selective tree cutting basis or in a manner that results in the clearing of only small areas of woodland, in most cases, will not be incompatible with wildlife use of the woodlands.

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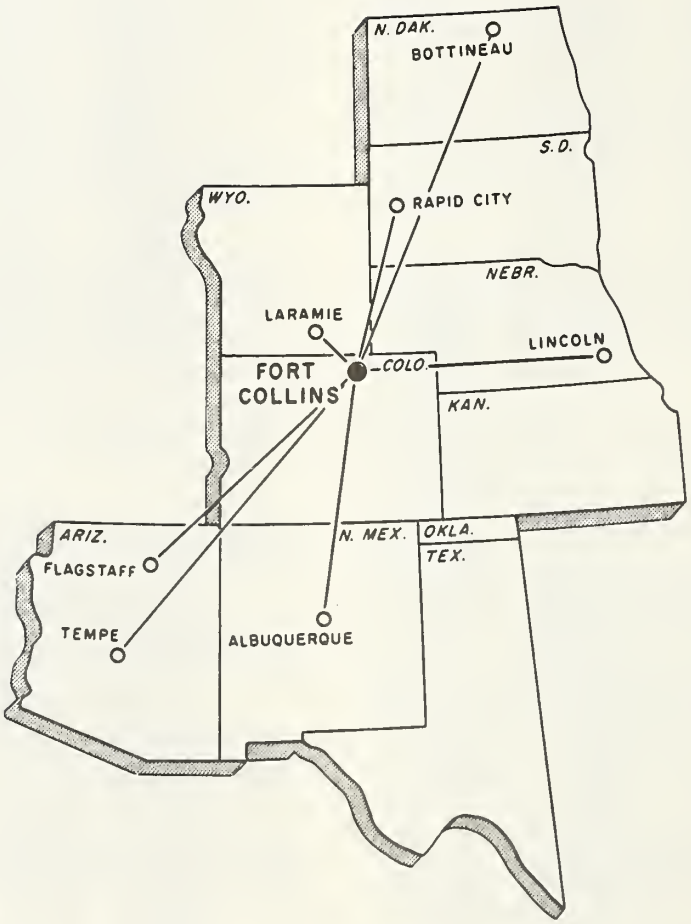
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